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Continuous Sticktogetherations and Somethingelsifications: How Evolutionary Biology Re-Wrote the Story of Mind

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Cognitive science is undergoing a rebirth, overturning much of the traditional thought established by people like Chomsky and Newell and Simon. This second-generation thought, exemplified by people like Clark, Lakoff, and Johnson, is pursuing the same project as the traditional thinkers, but with evolutionary considerations. This revision of cognitive science can trace its roots back to the American Pragmatists, while still attending to even the most recent work in neuroscience and evolutionary psychology. If one takes this embodied, evolutionary story seriously, we can eliminate many of the oppressive problems that plague cognitive science, including those surrounding qualia, intelligence, and even consciousness.

Keywords: embodiment, evolution, cognition

> We are not like other animals; our minds set us off from them. That is the claim that inspires such passionate defense. It is curious that people who want so much to defend this difference should be so reluctant to examine the evidence in its favor coming from evolutionary biology, ethology, primatology, and cognitive science. Presumably, they are afraid they might learn that, although we are different, we aren't different *enough* to make the life-defining difference they cherish. For Descartes, after all, the difference was absolute and metaphysical: animals were just mindless automata; *we* have souls. (Dennett, 1995, p. 370)

The reader will forgive, I hope, such a long introductory quote from another philosopher, but the underlying theme implied in Dennett's random remark is really the source of the present examination of the benefit to be gained by a collaboration between cognitive science and evolutionary studies. Cognitive sci-

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ence has largely been a field that sought to understand the complexities of thought, and informed the possibilities of artificial intelligence (AI) from the various disciplines of psychology, philosophy, neuroscience, computer science, and linguistics, with other inter-related fields sticking their noses in (or being pulled in unwillingly) whenever they had something relevant to offer in the quest to understand "mind." Whether that information was used to gain a deeper insight into our own human nature or to re-package bits of it for the sake of building an artificial version, the primary purpose of the field has been to explain the complex cognitive mechanisms that contribute to or produce consciousness. However, the traditional field of cognitive science, though still alive and manufacturing new students of the computational theory of mind, has been slowly approached and overtaken by what appears to be an almost entirely different field, also calling itself cognitive science, which takes seriously the implications of our embodiment. In fact, this revised version of cognitive science pays attention to the work of evolutionary biology, and can trace many of its roots right back to the early American Pragmatists, writing very soon after the publication of Darwin's *The Origin of Species*. These early writers, such as John Dewey and William James, immediately saw the implications of Darwinian thinking for philosophical notions of consciousness. Unfortunately, much of the foundational work in cognitive science overwhelmingly ignored this early thought and clung to the non-evolutionary view that thought really could be just simple symbol manipulation in the void.

If we look at what cognitive science has been, we can see what ignoring evolution has done to the field, and we can see the sorts of systems that have been built on this view in AI. The environmental contribution has been almost entirely ignored in this traditional view, as most clearly demonstrated by Newell and Simon in their seminal work on the Physical Symbol Systems Hypothesis. It was through this, the notion that, "a physical symbol system has the necessary and sufficient means for general intelligent action," that so much of traditional cognitive science went wrong (Newell and Simon, 1976, p. 111). Between this hypothesis and the Church–Turing thesis (see Boolos and Jeffrey, 1989, p. 52), traditional cognitive science grabbed a brain and a computer, noted the relevant comparisons, and ran with it. Ignored was the rest of the body, built up via evolution for various purposes. In fact, ignored was the evolutionary story altogether; it did not matter how the system came to be. Cognitive science became interested only in figuring out what the mind currently is and how we can better understand it in its current form. We can easily see this in the work of serious contributors to the field, such as Chomsky and Fodor. "The best game in town" was the one that noted only the highest level functions of the brain, and refused to acknowledge the evolutionary roles that other parts of the nervous system or the endocrine or respiratory systems played in the construction of a mind. Well, the best game in town now has an evolutionary story to tell, and cognitive science needs to sit up and take note.

Geoffrey Miller has pointed out that many of us (and not only cognitive scientists, but even the naïve laymen) have become "stingy materialists" in our quest to catalogue and dissect the various cogs that work to form consciousness. "A stingy materialist takes the view that subjective experiences may not be real if they have not yet been associated with particular brain areas or neurotransmitters or genes" (Miller, 2002, p. 85). I am tempted to agree with Miller, and point out that this has been one of the downfalls of the traditional project of cognitive science, most clearly demonstrated in the projects of AI that have been taken up with the view that thought is simple symbol manipulation. Unfortunately, it has been this view that has dominated the field of cognitive science and it is this view that has failed to see the light that the evolutionary story brings to bear on what mind is and where it came from. It is this stingy view, Miller says, that "results in an infantile view of human nature, in which people appear cartoonishly simple, portrayed in crude outline and primary colors" (p. 86). So many cognitive scientists have worked with this crude outline for so long that they seem unable to recognize the complexity that continues to be absent from their accounts, instead assuming that it does not exist simply because it has not yet been adequately explained by neuroscience.

One would think that a glimpse into the dark history of the field of psychology ought to remind us of the dangers involved in such stinginess, but it may be the fact that we are still crawling out of the behaviorist void, itself a backlash against the less scientific psychology of Freud and perhaps phrenology, that keeps us from recognizing how deeply we are still enmeshed in that behaviorism. People like Freud and the phrenologists did psychology a favor by showing us just how careful we have to be when trying to tease out the details of what appears to be the most complex and mysterious thing in the universe: our own minds. From both Freud and the phrenologists, psychology learned that falsifiability and scientific methodologies should not be altogether ignored, and that care must be taken before any ascription of causality can be made. And yet in our rush to avoid their errors, cognitive psychology fell too far in the opposite direction in a lot of ways, and much of the field remains stingy even now. (Admittedly, the stinginess of the behaviorists was just one extreme, but how many cognitive psychologists even today will accept any behavior as valid if it cannot be observed at least neuroscientifically?) The history of cognitive science is rife with these same problems, except many of the non-evolutionary assumptions became so primary for the field that a good chunk of what that field has become is built on a faulty foundation.

Thankfully, it seems as though cognitive science is in the middle of a rebirth. And this rebirth brings with it a history: a history of both evolutionary thought and evolutionary study. Even though this "second generation" is a sort of revision of the traditional project (but with an evolutionary twist),

its roots really stretch back at least to the American Pragmatists.[1] John Dewey set the stage for a successful cognitive science program when he wrote, "The Influence of Darwin on Philosophy" way back in 1910. He knew, even then, that "in laying hands upon the sacred ark of absolute permanency, in treating the forms that had been regarded as types of fixity and perfection as originating and passing away, the 'Origin of Species' introduced a mode of thinking that in the end was bound to transform the logic of knowledge, and hence the treatment of morals, politics, and religion" (Dewey, 1910, pp. 1–2). If only cognitive science had started from Dewey instead of Von Neumann, we might be much further along in the project today.[2]

Dewey recognized that the biggest problem in philosophy came from mistaking the structure of discourse for the structure of the world itself, and yet his warning was ignored when the digital computer made its debut and Alan Turing recognized that an algorithm is an algorithm, no matter where you instantiate it (Dewey, 1925/1958). Granted, some of the early Pragmatist writers may not have had the evolutionary story quite right, but their insights into the value that evolutionary thought brings to the study of mind and behavior shouldn't have been discarded just because they had a few of the details incorrect (see, for example, Reynolds, 2002; Ruse, 1986; Wiener, 1949). And it seems that, slowly but surely, cognitive scientists are returning to these thinkers as the springboard for an entirely new (and more successful) way to do cognitive science.

This evolutionary revolution in cognitive science can be successfully found in all of the various disciplines that together create the field. We can find exemplars of this view in philosophy (Andy Clark, Daniel Dennett, Mark Johnson), psychology (Geoffrey Miller), linguistics (Terrence Deacon, George Lakoff), neuroscience (Antonio Damasio, Vittorio Gallese, V.S. Ramachandran), and robotics (Rodney Brooks), just to name a few. Taken together, we can see that any successful cognitive science project must look at the evolutionary history of humankind. Traditional cognitive science treats the mind in isolation, as if it appeared in humans complete, as if we were always conscious and fully aware, capable of abstract thought. Instead, our minds became what they are in tiny evolutionary steps, distributing intelligence throughout our bodies and even the environment, and contrary to the traditional project of cognitive science, it simply does not make sense to assume that our consciousness is something as neat and clean as simple algorithmic symbol manipulation confined to our brains and nervous systems. Nature, as said by François Jacob, and repeated by Steven Jay Gould (1980), is a magnificent tinkerer, and not a divine artificer.

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[1]For an in-depth discussion of the second-generation of cognitive science, see Lakoff and Johnson (1999, pp. 77–78), where the term is quite possibly first coined.

[2]John Von Neumann is widely believed to have invented the architecture of the modern digital computer. See Goldstine (1972).

This does not mean, however, that consciousness is unknowable or even that AI is impossible — contrary to the ideas of many people who have drawn these conclusions (McGinn, 1989). It simply means that the story we have been lead to believe up to this point has been dramatically oversimplified — a crude outline using only primary colors.

It was another of the Pragmatists, William James, who pointed out that "evolution is a change from a no-howish untalkaboutable all-alikeness by continuous sticktogetherations and somethingelsifications" (quoted in Dennett, 1995, p. 147). The implication here is that even if we don't quite know how to talk about the details, we are adaptive creatures by nature. Once we were able to accept that we weren't put here as a finished product by divine nature, but instead cobbled together by bits and pieces of things that did the job well enough (though rarely if ever ideally), we continued to fail to recognize that our own minds would almost certainly not be this ideal system of static concepts and strict rules. Instead, much like Descartes's privileging of the human over everything else because of the soul, traditional cognitive science continued this blunder, but replaced the soul with the faculty of language. The proof for this lies in all of the traditional literature in the field of cognitive science, whether you choose to look at GOFAI ("Good Old Fashioned AI") in the vein of Fodor and Rey, or the connectionist literature of Rumelhart and McClelland. Even these apparently conflicting implementations of the research fail to examine the evolutionary origins of mind, instead focusing simply on a re-creation of the finished product, top–down. Take the traditional structure of concepts as an example: an object is considered to fall under the conceptual headline that it does based on a list of necessary and sufficient conditions for inclusion in that list. A chair, then, is something that is used for sitting, has four legs, etc. Language was assumed to capture a concept completely in such a form, although much of the more current work on concepts has demonstrated the failures of viewing concepts in such a way (Lakoff, 1987; Margolis and Laurence, 1999). And, as always, a quick glimpse at the Cyc project is likely to put the entire traditional project into perspective.[3]

Yet, hope remains for the field of cognitive science, in that enough researchers have finally stepped back and recognized that we cannot study the mind without studying its slow and gradual progression toward its current instantiation. Finally, it is being recognized that you cannot simply note the apparent similarities between a brain and a neural net and assume that means they are capable of the same things. Instead, the field is waking up to the fact that mind itself has a history, a very embodied history, and in order to study

[3]Information on the Cyc Project can be found online at http://www.cyc.com/cyc/cycrandd/overview where information can be found on the various publications related to the project. Briefly, Cyc is a knowledge database which was (and is) largely believed by many in traditional AI to be the most promising attempt to build a mind.

and even try to recreate the mind, we have to examine the entire organism of which it remains a part. It is not enough for philosophers to study the work of previous philosophers and merely point out where some premise does or does not follow from some others; instead it is increasingly obvious that to do any serious work in cognitive science, one needs to take in earnest the work of the evolutionary psychologists and neuroscientists, and not merely on the superficial level at which they have been given lip service in the past.

Take, for example, the neuroscientific evidence emerging that perhaps our abstract reasoning capabilities arise from piggy-backing on our sensory–motor systems (Edelman and Tononi, 2000; Gallese, 2003; Lakoff and Johnson, 1999). No one is claiming that this is the only way for such abstract systems to arise (at least not yet), but if we take this evidence at face value, we can observe an evolutionary story (and more importantly, evolutionary evidence in simpler organisms) that can go a long way toward helping us with an agreed-upon definition of intelligence.[4] What's more, once the evolutionary psychologists have concocted a reasonable evolutionary story from the neuroscientific evidence, the philosophers can work out the implications for our own minds, and then the computer scientists and roboticists can actually base their work on the evolutionary theories rather than just starting arbitrarily, as has largely been done up until now.[5] When you start with the assumption that our minds, as they stand now, are a finished product, it is easy enough to get caught up in the excitement of trying to replicate that idea. But the benefit of recognizing our minds as a state in a process is that it gives us so much more to work with. At the very least, it shows us what happens when we change various bodily systems in the same environment, and the resulting forms of mind that can result.[6]

Of course, to be fair, it is not as if the first generation cognitive scientists are entirely at fault for their failure to consider the evolutionary history of our minds. In fact, it has been argued by several people recently that our penchant for dualism is embedded in our thinking even from our earliest childhoods,

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[4]A standardized, general definition of intelligence should probably have been established decades ago in order to ensure genuine and useful discussion across and within disciplines, but an examination of the literature demonstrates that almost every researcher redefines the word as best fits his or her own project.

[5]There are a few very outstanding exceptions to this. For example, Rodney Brooks at the MIT AI Lab appears to have been working in robotics from the evolutionary viewpoint since at least the 1980s, and more independent researchers such as Steve Grand, who until recently was engaged in a similar research project of attempting to build a robotic creature that learns from the real environment instead of being programmed with a database of given knowledge. It seems that in the last couple of years more and more roboticists are taking this viewpoint seriously.

[6]This, of course, hinges on the fact that people overcome a vast history of arrogance regarding animal intelligence, largely arguing that animals do not share "consciousness" with us (whatever that may be). It is time to accept that the scientific evidence simply does not back up that arrogance, as implied by Dennett.

and in fact (ironically) has evolutionary utility as well (Bloom, 2004). So when the earliest AI researchers believed it might be possible to remove the symbols, which constituted the substance of mind, from the body, and simply instantiate them on a different body, it was because evolution had built this split into us, and our language reinforced it. In fact, it is so reinforced that to discuss body and mind as one thing, truly one thing, and not simply some convenient cooperative system, is extraordinarily difficult. The mind–body distinction is so embedded in our language that we simply are unable to discuss what mind might be if it really is distributed throughout our entire bodies, or even worse, if it relies as heavily on our environment as it appears to (Clark, 2003). Even to those of us who believe that mind is truly equal to body in many respects, it is highly unlikely that others would understand us unless we used both words. Each word, body and mind, refers to such distinct aspects of our experience that any attempt to talk about either one as encompassing the other would be misunderstood because of the history of the vocabulary.

Once cognitive science as a field (preferably one in which both the first and second generations are given a fair voice, since, as with all things, the truth probably lies somewhere in the middle) accepts the level at which this dualist thinking is embedded in our language and perhaps even our genetic makeup, we can begin to start working to overcome these known barriers and actually try to learn something about the nature of the human mind as it has developed via evolution, since this is truly the only starting place worth considering. A wonderful example of how this approach can be successful can be found in Pinker (1995), who took his training in traditional cognitive science and supplemented it with a large dose of evolutionary thought. The result was a very comprehensive, informative, and well-respected theory of natural language evolution. Even though the details may be debatable, the encompassing of evolutionary thought spurred on a new and more robust theory than the previous views had allowed for.

When we ignore evolution, we endanger our theories of falling along the wayside as soon as more of the evolutionary story solidifies within accepted scientific discourse. Much like the infamous "God of the Gaps," a theory of mind that fails to address evolutionary concerns is a theory of mind that will eventually be replaced, perhaps in small increments, by one that does. Why settle for dealing exclusively in the leftover bits that evolution hasn't worked through yet when you can start at the beginning (literally) and instead produce a robust theory that accounts for all of our current scientific knowledge? What's worse, as Gazzaniga notes, "If the evolutionary perspective is simply set aside, the data collected by psychologists and neuroscientists are likely to be grossly misinterpreted" (1998, p. 6). It isn't just that the theories will be threadbare and feeble, but they may actually be entirely incorrect when we fail to keep evolution in the forefront of our research.

Up to this point, the primary discussions in cognitive science have revolved around those aspects of mind that can be most readily agreed upon and discussed as clearly-defined aspects of our consciousness, such as language, reasoning, and conceptual content (but not conceptual structure). However, the field largely ignores those things which we as stingy materialists cannot quantify (yet), such as creativity, imagination, poetry, humor, and art. It seems unlikely we would accept as conscious (or perhaps even as intelligent) any system which lacked at least some of these traits, since they seem to be exactly those mysterious aspects of our humanity that bring us to question minds in the first place. And yet cognitive science rarely addresses these issues, because they are largely undefined and extremely hard to place in the context of a closed system of symbol manipulation.[7] Imagine what progress could be made toward understanding consciousness if these issues were addressed! Now, simply look to some of the evolutionary psychology research done by Miller (2000) on sexual selection, and note that many of these things are, in fact, discussable in the language of a laboratory. Furthermore, Miller's theories show that evolution can account for these traits without making them any less exciting or special than they actually are (and without privileging them to the uniquely human domain that we continue to insist upon). Miller's view, unlike many of the other theories that have dared to touch upon taboo or difficult subjects such as the evolution of creativity, does not relegate it down to some side-effect of another evolutionarily useful system. Rather, he tells us, "it evolved for a reason, partly as an indicator of intelligence and youthfulness, and partly as a way of playing upon our attraction to novelty" (p. 392). Even if you disagree with Miller's theoretical explanations of these more abstract aspects of our intelligence, the fact that he attempts an evolutionary examination of such traits (and has data to back up his claims) demonstrates that these topics can be successfully included in our scientific worldview, and furthermore ought to be. And there is no reason why cognitive science should ignore them, especially when the input of evolution is attended to (see also Dissanayake, 1995).

Perhaps using the word "revolution" when referring to the movement from the old traditional cognitive science to the new cognitive science is incorrect. Perhaps what is occurring is more of a reformation, retaining some of the older information and revising the rest, rather than an entirely new field overtaking the old. This is actually questionable and debatable, and not too important for our discussions. It should be noted, however, that the distinction may matter in the world of academic politics, determining how many people actually jump ship from the static, non-evolutionary story and move on to the

[7]One notable exception of this is in the work of people like George Lakoff and Mark Johnson, who are among the very few cognitive scientists willing to talk about imagination and creativity, as well as morality. These topics are only very recently being approached by cognitive science in a systematic way.

acceptance of a truly embodied mind. In fact, it seems quite likely that the perception of this difference as a revolution rather than a reformation is exactly what prevents many intelligent scientists from seeing this evolutionary light. There seems to be no other explanation for why many people, people who have done important, brilliant work, can continue to ignore the role of evolution and change in both our bodies and our theories. It seems highly unlikely that the content of our minds is static any more than our theories of that content ought to be. Both need the evolutionary story, and both can greatly benefit and grow from accepting that fact. Perhaps the second generation of cognitive science ought to be considered the cognitive reformation rather than an embodied revolution.

Take, for example, this extended analogy as evidence for just how drastically the evolutionary viewpoint can improve cognitive science, and just how quickly it can provide new insights into previous problems. In the field of cognitive science, we have all been plagued by the qualia problem at some point, and seen how even tentative non-evolutionary considerations of it can drive good philosophers to become dualists. But it doesn't have to be that way! We can genuinely consider phenomenological experience and not need to turn mystic if we, as cognitive scientists (with some emphasis on the latter word in that title) just think about our minds as embodied and products of evolution. Think of it this way: imagine stumbling upon a human stomach out of context, unaware of what it is. (A strange thing to imagine, indeed! But no more strange than imagining a mind without a body, if you will.) As a scientist, you may go about studying the stomach as a complete entity. You may learn something about what it does (it digests), and you may learn quite a bit about the chemistry involved. However, think of the impoverished notions you will have of both its input and output! (After all, a good deal has happened to that food before it ever reaches the stomach, and without the rest of the body, you would never guess what that input would resemble.) Furthermore, and perhaps most disconcerting, by studying and examining this thing down to the very molecular level, you may mistakenly believe that you have exhausted all possible knowledge of it! (Much like the traditional cognitive scientists believe that by learning everything there is to know about a neuron, they have exhausted what there is to know about a mind.) Why should we have been led to believe that a brain could be extracted from the body any more than a stomach could be? Our knowledge of an out-of-context body part will always suffer when not viewed in terms of the whole, and as soon as the whole is considered, we cannot help but confront the functional roles of the various parts as built up via evolution. To study the mind without considering evolution is irresponsible at best, and dangerous at worst.

As for the problem of qualia, perhaps looking at the stomach once more, but with evolutionary biology in mind, can help eliminate the problem alto-

gether. (Not only do I believe that it can, but I worry about how easily some of these issues are resolved when the body is viewed as one whole entity — how long we have been concerned with false problems!) Just as the stomach out of context would produce new and interesting problems (why does it break down these larger pieces into usable nutrients when they don't seem to do anything other than get transported out of the system?), the brain out of context will present the same issues. How on earth do these neurons not only produce a felt quality to my experiences, but how is it that this quality is so uniquely my own that even if you knew everything there was to know about my brain, you could never know what it feels like to experience my pain (for example)? The people who ask this question (Block, 1990; Nagel, 1974) might as well be asking why it is that someone else cannot digest my food for me. Because of what digestion (and felt experience) is, and the evolutionary purpose it serves, asking why it cannot be done by someone else is a non-question, and not the dualist dilemma it has grown to become. Digestion occurs when the stomach of a given body breaks down those nutrients and transports them to certain places *within that body*. Felt experience occurs when certain parts of the body report on states of other parts of the body to possibly some more central overseer (Damasio, 1999). No one else can experience my feelings anymore than they can digest my food. Each is a state of my own body, by definition of what they and bodies are. Once again, it is our language and evolutionary penchant for dualism that really creates the illusory problem and leads us to pursue it as something real, when in fact it is entirely paradoxical to even ask the question.

Antonio Damasio has given extensive evolutionary arguments for why consciousness itself arose, based on his clinical observations. He claims, convincingly, that "consciousness begins when brains acquire the . . . simple power . . . of telling a story without words, the story that there is life ticking away in an organism, and that the states of the living organism, within body bounds, are continuously being altered by encounters with objects or events in its environment, or, for that matter, by thoughts and by internal adjustments of the life process" (1999, p. 30). Why do brains acquire this power? He has his theories, and they certainly have their merits, but this is exactly the question for cognitive scientists to get busy answering, and it couldn't be more clear that to do so, we have to start from evolution. That does not mean we should throw in some evolutionary story after we have developed our own theories, hoping to ensure that the two are compatible. It means, quite simply, that without evolution as the springboard for our examination of mind, we have absolutely no hope of learning what, precisely, consciousness is, and how exactly it works (see Gazzaniga, 1998). [And for anyone keeping track, that spells failure for just about every subfield within cognitive science since our language, our concepts, our experiences, our pathologies and our ability to

recreate all of these things in a machine hinges on somehow getting a handle on consciousness.] So it is time for us to throw open the doors of cognition to evolutionary biology, and stop being so arrogant as to believe we can possibly exhaust our knowledge of mind by studying a disembodied brain.

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